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ABSTRACT

In recent years science educators have placed increasing emphasis on the importance of understanding student knowledge. The research aimed at exploring student knowledge--misconception research, nature of science studies, and conceptual change research--has proved useful in telling us what concepts students know before and after instruction. However, this research tells us little about how students' science knowledge interacts with instruction to structure the teaching/learning process. Worldview is an ideal theory to help researchers answer questions about the role of science knowledge in the teaching/learning process. Yet, it is relatively new to science education literature, and there is little consistency as to which methods of handling worldview data would yield insightful studies of student knowledge. This article examines worldview literature from science education and other disciplines to tease out the theoretical commitments, methods, and applications that are most conducive to investigating the dynamic interaction of student knowledge in instructional settings. (Contains 42 references.) (Author/MM)

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A REVIEW OF WORLDVIEW RESEARCH IN EDUCATION: ANALYZING THEORY, METHODS AND APPLICATIONS

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Abstract

In recent years science educators have placed increasing emphasis on the importance of understanding student knowledge. The research aimed at exploring student knowledge – misconception research, nature of science studies, and conceptual change research – has proved useful in telling us what concepts students know before and after instruction. However, this research tells us very little about how students' science knowledge interacts with instruction to structure the teaching/learning process. Worldview is an ideal theory to help researchers answer questions about the role of science knowledge in the teaching/learning process. Yet, it is relatively new to science education literature and there is little consistency as to which methods of handling worldview data would yield insightful studies of student knowledge. This article examines worldview literature from science education and other disciplines to tease out those theoretical commitments, methods, and applications that are most conducive to investigating the dynamic interaction of student knowledge in instructional settings.

Introduction

The application of worldview theory as a research tool is growing in science education literature. In the sixteen years prior to 1990 (1974-1990) fewer than five papers dealing with worldview and science education could be found in science education journals. However, since 1990 the rate of articles published in refereed science education journals has quadrupled and the number of worldview studies continues to grow. The increased interest in worldview theory is likely the result of shifting epistemological commitments. As educators reject positivistic notions of teaching and learning and adopt a constructivist orientation, greater emphasis is placed on the conceptions held by students and teachers, how curricula and instruction shape those conceptions, and the process by which those conceptions change over time. For many, worldview theory is seen as an ideal (even necessary) tool for exploring the knowledge structure and content of students and teachers (Cobern, 1996; Lewis, 1997).

Although there is a growing interest in the concept of worldview, current research lacks agreement regarding the types of theoretical commitments, methods, and reporting that capitalize on the strengths of worldview theory. Such agreement is necessary to bring uniformity to worldview research and to guide the work from a burgeoning interest into a mature body of literature. The purpose of this paper is two-fold. First, it provides a picture of worldview theory as it exists in science education literature. Second, it explores how educational researchers outside of science education have applied worldview theory. My hope is that work from other disciplines will inform science educators who use worldview theory. To accomplish this two-fold purpose, I review a subset of refereed journal articles that deal with worldview, highlighting the

theory, methods, and applications used. Approximately half of the articles reviewed are from science education literature.

Worldview theory can inform many aspects of science education research including: teachers' conceptions of science (Ogunniyi, Jegede, Ogawa, Yandila, & Oladele, 1995); students' conceptions of science (Cobern, Gibson, & Underwood, 1995; Lassiter, 1994); text analysis (Kilbourn, 1984); and teaching science across cultures (Allen, 1995) to name a few. However, the focus of this review is on the application of worldview theory to student knowledge research.[1] Therefore, I underscore features of worldview theory that make it a powerful tool for exploring knowledge structure and content, and I evaluate the literature presented according to those features. Before defining worldview and discussing its explanatory power, I wish to address the importance of students' knowledge. The reason for this discussion is that it uncovers philosophical assumptions which serve to guide student knowledge research and at the same time raises questions for student knowledge research that worldview theory could effectively accommodate.

Importance of Students' Knowledge

Why is student knowledge important? This question may at first glance appear trite and the answer, self-evident. Yet, the answer we give plays a significant role in shaping our investigation of student knowledge. Few would dispute that an educational experience should result in students who have acquired or constructed some body of knowledge about something.

However, theories of learning prominent before the recent dominance of constructivism, treated students' knowledge as though it were less than a dynamic factor in the teaching/learning process, that it was solely an outcome of a set of teaching variables (curriculum, instructional method, intervention, environmental condition, etc.). Moreover, it was assumed that "the right" teaching variable would yield students possessing a predictable and predetermined set of knowledge, regardless of the knowledge those students held prior to teaching. Hence, the primary focus of investigations from this era was on teaching variables (refer to Figure 1). The variables were often correlated with resultant knowledge with minimal regard for the teaching/learning process by which teaching variables led to resultant knowledge, and little regard for the part played by students' knowledge in shaping that teaching/learning process.

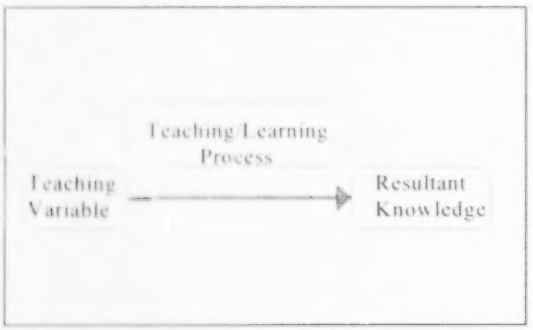

Figure 1 - Research Focused on Teaching Variables

The popularity of this view has waned a great deal; today a significant number of educators operate from the tenets of constructivism. Instead of viewing students' knowledge as the incidental, predictable byproduct of teaching, knowledge has come to be regarded in

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[1] Student knowledge research refers specifically to three bodies of literature: misconception studies, nature of science studies, and conceptual change studies.

constructivist terms as being inseparable from the knower (von Glasersfeld, 1993). Further, each knower constructs knowledge differently. Three bodies of research have grown out of this new perspective and I refer to them collectively as student knowledge research.

The first is misconception literature (e.g. Hashew, 1988; Lewis & Linn, 1994), which is a large body of research that documents what students know (or don't know) about science concepts. The second is student views on the nature of science literature (e.g. Meichtry, 1993; Ryan, 1987), which provides insight into how students understand the scientific enterprise. The third is conceptual change literature (Chan, Burtis, & Bereiter, 1997; Hewson & Hewson, 1984; Posner, Strike, Hewson, & Gertzog, 1982), which has largely sought to identify strategies for modifying teaching variables (primarily instruction) to yield more acceptable resultant knowledge. While these bodies of literature acknowledge that student knowledge is an important factor in the teaching learning process, the primary focus of investigation has shifted from teaching variables to what students' know or don't know as a result of instruction (refer to Figure 2).

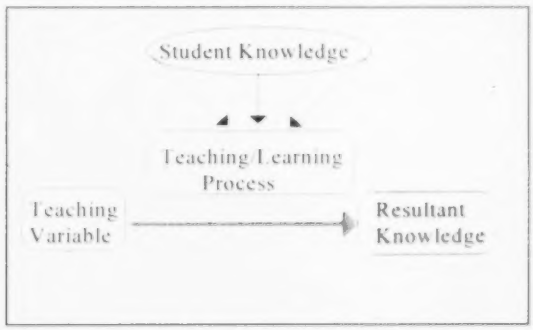

Figure 2 - Research Focused on Resultant Knowledge

By focusing investigations on resultant knowledge, student knowledge research fails to capitalize on one of the primary assertions of constructivist philosophy: that learning is an active

process in which prior knowledge is the basis for the construction of new knowledge. Why is student knowledge important? Because (a) it is a dynamic factor in the teaching/learning process and (b) it is the foundation from which students draw to learn new concepts and ideas.

If student knowledge is a dynamic factor in the teaching/learning process it is not enough to simply report what knowledge students possess *after* being taught. Research should also tell us how student knowledge *participates* in the teaching learning process. How does it add to or detract from teaching variables to produce an educational outcome? Moreover, if student knowledge is the foundation from which students draw, then student knowledge research should also provide a view of the landscape of that foundation. It should tell us what portions of the knowledge foundation students draw from, and why they draw from some knowledge or knowledge sources and not others. Questions such as these have not only gone unanswered in student knowledge research, but they have rarely even been posed as important questions for science educators. Hence, in addition to research which looks at resultant knowledge, it is also important to focus on the dynamic of student knowledge in the teaching/learning process (refer to Figure 3).

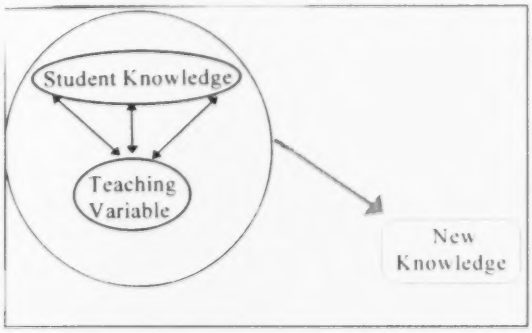

Figure 3 - Focus on Knowledge in the Teaching/Learning Process

As researchers begin to focus more on student knowledge as a critical factor in the teaching/learning process the following questions become important. What do students know? How is their knowledge organized? What knowledge is common to *most* students and what knowledge is *unique* to certain demographic groups? How can this knowledge be accessed to enhance learning outcomes? Herein lies the potential of worldview theory for student knowledge research, that its basic assertions provide direction for researchers seeking to answer these and many similar questions. To date, worldview studies in science education have only capitalized on the strengths of worldview theory to a small degree. This under-utilization is attributable in part to the lack of established methods for collecting, analyzing and reporting worldview data.

In the next section of this paper I give a brief overview of worldview theory, identifying several uses of worldview in educational research literature. I then provide a more detailed summary of a specific model of worldview (the logico-structural model), highlighting four assertions of the logico-structural model which make it especially promising for student knowledge research. Finally, I provide an explanation of how the four assertions were used to evaluate the studies presented in the paper.

Worldview theory

General Description

The term worldview enjoys frequent use in literature from a variety of disciplines; it is also quite old, used as far back as the time of Aristotle. However, the meanings applied to worldview vary considerably. One approach is the use of worldview as a *synonym* for talking about culture. A more utilitarian approach is to regard worldview as something that is

measurable; results in observable phenomena (if it is not observable itself); and is an important factor in determining how and why people think and behave as they do. Of this later approach there are three uses of worldview germane to this paper. (While many more uses may exist this review only distinguishes between the three summarized here). The first is the thematic use, wherein worldview refers to particular cognitive dispositions or orientations which are given thematic labels. An example comes from the work of Forrest (1995) in which mistrust, anomie, and belief in a just world are identified as three worldviews and are correlated with critical life experiences. In the context of Forest's study the "worldview" of interest is actually only one component of a larger worldview. So the three worldviews - mistrust, anomie, and belief in a just world - are actually themes or metonyms used to represent general tendencies that influence the thinking of individuals.

The second use of worldview is paradigmatic, wherein worldview is used to refer to the shared assumptions and the resulting perceptions of a group. This is similar to Kuhn's (1970) paradigm. So for example, we sometimes refer to a Christian worldview to understand the shared beliefs and perceptions held by those in the Christian community. Studies of culture generally invoke a paradigmatic understanding of worldview.

The third use of worldview differs from the first two in that worldview is taken to be the total of a person's understanding of himself, the world, and his place in the world. So unlike the cognitive disposition use, mistrust for example would not be a worldview in itself but rather a characteristic of a worldview. And unlike the paradigmatic use, worldview is not reduced to those assumptions that groups share in common, but is rested with the individual.

One of the most comprehensive frameworks that treats worldview in this way is Kearney's (1984) logico-structural model. Kearney's model has two advantages, first it is based on an extensive analysis of empirical studies - most from anthropology. This differs from previous attempts to give theoretical underpinnings to worldview (e.g. Jones, 1972), which rely more on philosophy than empiricism. The second advantage is that it defines worldview as the *total* of a person's thinking and as belonging to the *individual*. This is extremely beneficial for conducting student knowledge research. Because prior knowledge is the foundation out of which new knowledge is constructed, it may be a disservice to reduce that foundation (or worldview) to one or two overriding themes in an effort to understand how it contributes to the teaching/learning process. In fact, Cobern (1993) and Cobern, Gibson, and Underwood (1995) have found that it is possible for individuals to agree on a statement of fact, yet arrive at drastically different conclusions due to related assumptions. Also, because each knower constructs knowledge differently, it follows that to understand what knowledge is constructed and why, the preferred theoretical frame is one that attends to the worldview of the individual knower rather than the group.

Power of Worldview to Assess Students' Knowledge

Following are four assertions of Kearney's logico-structural model used to evaluate the articles in this review. There is also an explanation of how the assertions can help researchers address questions important to student knowledge research. The first assertion is that *a person's worldview is modified by the historical, social, and cultural environment*. This assertion of the logico-structural model of worldview makes it a powerful tool for assessing students' knowledge

in that it situates worldview in a historical, social, and cultural context. It has long been argued that environmental conditions play a major role in shaping people's thinking. In many instances, however, the relationship between environment and thinking has been oversimplified. Analyses that report low socioeconomic status, race, or gender as the environmental cause, which leads to some effect provide a fitting example.

Many times these analyses do not show *how* SES, race, or gender lead to unique patterns of thinking (e.g. Post, Stewart, & Smith, 1991; Thomas, 1984). In addition, such analyses do not explain *why* some members of demographic groups show patterns of thinking that are contrary to the thinking of other group members. Ogbu (1992) made this point in arguing for a closer look at patterns of achievement among various minority groups. His argument is that if minority group membership were *the* factor, which caused low academic achievement, then all minority group members should exhibit the same low achievement. Another interpretation is that several environmental factors result from minority group membership and they work with and against one another to modify a person's worldview. To address minority group membership without giving an account of other environmental factors yields an incomplete analysis of the influence of the historical, cultural, and social environment.

The logico-structural model of worldview theory acknowledges this less direct, more complicated worldview-environment relationship. In a single middle school class of thirty students, there are thirty different environments being engaged at any given time. In this class, the son of a banker has environmental experiences that are substantially different from the daughter of a steel worker who sits beside him. Each attends to different environmental objects: one may be fixated on the lesson being presented, while the other is focused on the steel worker's

daughter. Each interprets class activities through lenses shaped by history, culture, and socialization. Whereas one may perceive class as the presentation of interesting information, the other may perceive the annoyance of a teacher's ranting. One may be in a class with thirty students from families that are economically superior, while the other may be in a class of twenty-five students who are socially backwards (nerds and freaks) and only five students who are socially relevant.

By acknowledging that social, cultural, and historical environment is critical in modifying a person's worldview and by treating each person as having a unique worldview, the logico-structural model allows for investigations that explore the role of environment in shaping students' thinking. This is an important concern for student knowledge research that aims to investigate the dynamics of student knowledge in the teaching and learning process.

The second assertion (which is closely related to the first) is that *a person's behavior is directed by their worldview*. This assertion adds to the power of the logico-structural model in that it provides a source more immediate than environment for explaining behavior. While it may seem obvious that a person's worldview influences their behavior, the assertion is best appreciated when contrasted against research that takes human behavior to be primarily the result of environmental factors giving only moderate acknowledgment to the cognitive intermediary. Examples are found in studies, which examine the impact of teaching practices (Brookhart, 1997; Stohr-Hunt, 1996), or demographic variables (Maple & Stage, 1991) on students' science achievement. These studies provide important insight into the conditions conducive to achievement, but they are less able to explain *why* those conditions promote achievement; or

more specifically, *how* those environmental conditions exert influence over the behaviors that characterize student achievement in science.

The logico-structural model, by positioning worldview as the intermediary link between environment and behavior, directs our attention away from environmental conditions and towards worldview as the primary determinants of behavior. Environment then, becomes important not for its influence on behavior but for its influence on worldview; and to understand behavior we look to worldview. One implication of this position is that we can better explain why students who experience similar teaching practices or demographic variables exhibit different behaviors. In our class of thirty middle school students, for example, the steel worker's daughter and the banker's son understand the relationship between themselves and the class differently, as well as the relationship between themselves and the teacher, themselves and the text. They feel differently about their ability to control and to participate in the surroundings so their perceptions of class activities differ. As a result their behaviors differ.

The third assertion is that *all worldview content can be organized into first- and second-order assumptions*. This marks a shift away from thinking about students' cognition in terms of attitudes, beliefs, knowledge, opinions, self-efficacy, and similar traditional cognitive constructs. The primary advantage of this shift is that traditional cognitive constructs are inventions of *researchers* and do not necessarily represent students' knowledge, as it exists in their minds. So a study exploring the impact of self-efficacy on students' choices of science careers, Post (1991) for example, does not consider the influence of religious *beliefs*, *knowledge* of what scientists do, *attitudes* towards the role of scientists in society, and similar constructs.

Conversely, by organizing cognitive content into first- and second-order assumptions student knowledge can be more accurately represented. Any student knowledge (whether beliefs, attitudes, opinion, etc.) can be stated as an assumption or set of assumptions; and the collection of all knowledge or assumptions is a student's worldview. First-order assumptions differ from second-order assumptions in that they are (a) fundamental to a person's worldview, hence resilient to change; (b) pervasive and apply to a wide range of phenomenon; and (c) not easily articulated, people are generally not conscious of them. Second-order assumptions by contrast are (a) not fundamental to a person's worldview, they change more readily; (b) context dependent, applying only to specific situations or phenomenon; and (c) readily articulated.

This distinction is an important one for understanding students' knowledge. Consider misconception research, much of which is aimed at identifying students' second-order assumptions. There is a wealth of information on how students' understanding of science concepts is not in line with official science knowledge, yet less is known about knowledge, which underlies their misconceptions – the first-order assumptions. For example, with physics concepts there are many misconceptions on the principles of electricity, specifically circuits and electric current. Slotta & Chi (1996) found that novices and experts differ in their classification of these concepts. For experts, electric current is a process along with osmosis, heat transfer, and similar physics processes. Novices, however, "...tend to consider concepts such as heat, light, forces, and electrical current as belonging to the MATTER category, either as material substances or as properties of material substances" (p. 255). For both novices and experts the classification of these topics is a first-order assumption. They are largely unaware of their classification schema: which only becomes apparent in their descriptions. When describing

electric current, experts use words like *transfer*, *interaction*, and *simultaneous* whereas novices use terms like *block*, *contain*, and *supply*.

These contrasting ways of understanding are grounded in first-order assumptions - (a) the novices are not necessarily aware that they speak of heat, electricity, etc. as though it were matter; (b) their tendency to equate these process to matter is at the foundation of their worldview structure; and (c) the classification is applied across contexts whether at home when someone is "letting the heat out of the house" or at school when the heat "travels from one container to another"

The final assertion is that *worldview can be organized into seven universal categories: self, other, relationship, classification, causality, space, and time*. These seven categories represent boxes into which all worldview content can be placed. The primary benefit of the seven universals is that they are a means of describing and comparing worldview research within and among disciplines and cultures. While there may be many categorization schemas that enable such comparisons, Kearney's (1984) seven universals offer the decided advantage of being *necessary* categories of human thought. In Kearney's words,

> The basic requirement of this framework is that it be *applicable to any human world view* [italics added] without greatly distorting it. It is in this sense analogous to the diagnostic categories of doctors. When a doctor examines patients he has in mind definite notions about human anatomy and physiology that allow him to describe the patient's state of health. Although the doctor is confronted with a wide variety patients, he can presumably describe the most significant medical facts about them in terms of dimensions and features that are common to all patients, e.g., blood pressure, pulse, respiration. In a similar manner we must discover a universal set of diagnostic categories to describe world views. Other possible universal dimensions of worldview can be derived or posited for various purposes, but the ones that I present here appear to me to be the minimal ones for adequately analyzing and describing a world view as a dynamic logico-structurally integrated system of knowledge (p. 65-66).

Kearney goes on to describe the seven categories and how each is necessarily derived from the others. Beginning with the concept of *Self*, Kearney argues that all humans have a Self awareness; and as a consequence they are also aware of things that are not Self. Kearney refers to this non-Self as *Other*. Because Self operates among the Other (eating, breathing, sleeping, etc.) humans are aware that some type of *Relationship* exists between the two. Relationships also exist within the groupings of Self and Other. Awareness of Self, Other, and the items comprising each group necessitate that they be organized in some way giving rise to the *Classification* universal. The Relationship and Classification universals differ in that the former includes an awareness of interaction between Self, Other, and their constituent parts, whereas the later refers to the systems humans use to group Self, Other, and their constituent parts. If there are interactions between Self, Other, and their constituent parts then the nature of these interactions is delineated by the notion of cause, leading to the *Causality* universal. This universal contains assumptions about the nature of these interactions; and the interactions are understood in light of assumptions regarding the *Time* and *Space* in which they take place.[2]

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[2] Kearney (1984, p 65-68 & 106-107) and Cobern (1991, p. 43-62) expand on this summary of the logical necessity of the seven universals.

Findings of the Literature Review

Article characteristics. The articles reviewed were assessed on eleven characteristics: type of article, area of discipline, use of worldview, research design, methods of data collection, sample, methods of data analysis, and articulation or application of the four assertions. All articles reviewed were classified as one of two types: either a report of empirical research or an essay. No literature reviews, descriptions of practice/interventions, evaluations or reports were examined. The articles' area of discipline was determined by examining the journal in which it was published and the literature cited within each article, which gave grounding and context for the work. There were three possible categories for the use of worldview: thematic, paradigmatic, or logico-structural. These three uses of worldview are described in pages 8-10 of this paper. While the uses are not mutually exclusive there was very little overlap in the articles reviewed. In one instance (Sodowsky, Maguire, Johnson, Ngumba, & Kholes, 1994) more than one application of worldview was used so both categories were listed.

Research characteristics. Research design, methods of data collection, sample, and methods of data analysis apply only to reports of research. Information reported in this review reflects what authors presented in the text of their articles. There is no attempt in this review to assess the merits or fit between worldview theory articulated by authors and their chosen methods of handling data. Instead, information on data collection and analysis is intended to provide a picture of the range of data handling techniques and to examine the degree to which those techniques fit worldview theory as articulated in this paper.

Logico-structural assertions. Assertion one is that a person's worldview is modified by the historical, cultural, and social environment; assertion two is that a person's behavior is directed by their worldview. Articles were assessed to determine if the authors acknowledged these relationships between worldview, behavior, and environment *in their articulation of worldview theory*. Assertion three is that all worldview content can be organized into first- and second-order assumptions; and assertion four is that worldview can be organized into seven universal categories. Articles were also assessed to determine if assertions three and four are reflected *in the methods of data collection or analysis*.

Articles Characteristics[3]

Type of article. Of the eighteen articles reviewed twelve (67%) were reports of empirical research and six were essays. Of the six essays, three (though not literature reviews) synthesized extant research of different cultural groups to present suggestions for practice in light of the worldview of each group. If one regards these essay/syntheses as research articles, then the total number of research oriented papers is fifteen of eighteen (83%).

Area of discipline. Eight of the eighteen (44%) articles deal with science education. This was intentional as I attempted to have an equal number of science education articles and non-science education articles. Therefore, no conclusions should be drawn regarding the volume of science education's contribution to worldview literature. Of the remaining ten articles, five (50%) were from some area of psychology and only two (20%) were from anthropology. This

[3] For the remaining summary refer to Appendix A which contains a chart of the articles reviewed and the eleven characteristics.

suggests that the worldview construct is more frequently applied in the fields of psychology and counseling psychology. However, as will be seen, the use of worldview varies, and is clearly divided along disciplinary lines.

Use of worldview. Of the eighteen articles, six employed Kearney's logico-structural model of worldview and a seventh described worldview in a way closely associated with logico-structuralism, though the logico-structural model was not identified in the text. So seven of eighteen articles (39%) used the logico-structural model. Seven of the eighteen articles (39%) used a thematic approach to worldview. Two of the thematic approaches employed themes from Pepper's root metaphor theory (as cited in Proper, Wideen, & Ivany, 1988). Four of the eighteen articles (22%) employed a paradigmatic use of worldview theory; and one of the eighteen articles (6%) used worldview as a term that is synonymous with culture. One of the articles used both a thematic and a paradigmatic approach; the article was included twice (once for each usage). This will explain an apparent over-counting.

Of the seven articles using the logico-structural model, six were from science education, and the seventh (the logico-structural-like article) was from psychology. Of the seven articles using a thematic approach four were from psychology, one from science education, one from cross-cultural education, and one from higher education. Of the four paradigmatic uses of worldview two were from religion education, one from science education, and one from psychology. It is clear that the logico-structural model is predominant in science education, the thematic approach is predominant in psychology, and the paradigmatic approach is predominant in religion education.

Research Characteristics

Twelve articles (six in science education and six in other disciplines) were reports of research and the description which follows is limited to that subset. Eight of the twelve (58%) research articles had a statistical research design. Three of the statistical articles were from science education literature. These eight statistical studies employed a variety of instruments. The most frequently used instrument was the Scale to Assess World Views (SAWV). It was used in 3 studies all from psychology. Other scales used were the Belief System Analysis Scale (BSAS), Organicism-Mechanism Paradigm Inventory (OMPI), and the Test of Preferred Explanations (TOPE). Each of these instruments, except for the TOPE was used in a thematic study; the TOPE was used in a logico-structural study. Of the two remaining science education statistical studies, one used a likert-type instrument and the other used an open-ended questionnaire.

Most of the studies using statistical instruments to collect worldview data relied on a thematic approach to worldview. Even two of the three logico-structural studies had tendencies towards reducing worldview to themes. Ogunniyi (1995) categorized worldview presuppositions into eight predetermined groups (or themes): mystical, magical, rational, parapsychology, spiritism, science, pseudoscience, and metaphysical. Lawrenz (1995) also used theme-like categories though theirs were developed from the data. Cobern's (1997) study is the only of the three that does not resemble the thematic approach. He measured how close or distant participants preferred explanations were from a scientific explanation.

Four of the research reports were not statistical; there was one discourse analysis, one case study, and two interpretive reports. Three of these four studies are from science education literature and two use the logico-structural model. The fourth is from cross-cultural education

and uses a thematic approach. All of these studies use interpretive methods of data collection, which include participant observation, audio- and videotaped transcripts, interviews, artifacts, and researcher summary forms. Contact with participants range from two or three interviews to an eighteen-month field presence.

McCabe (1994), Cobern (1993), and Allen (1998) present findings that are especially insightful. There is a fullness in their descriptions, which paints pictures of the participants worldview contents. This is not to say that they present complete worldviews, it is to say that the reader is not left with questions about the consistency of participants worldviews. The same cannot be said for some of the other studies. This fullness of representation is, in my opinion, the result of the logico-structural approach in concert with qualitative research designs.

Logico-Structural Assertions

Worldview-environment-behavior relationship. Fourteen of the eighteen articles (78%) acknowledge a relationship between environment and worldview; and thirteen (72%) also acknowledge the relationship between worldview and behavior. Of the studies that do not articulate this relationship two are from science education and two are from counseling. This should not suggest that authors were unaware of the importance of the relationship. In fact quite the opposite seems to be the case. It may be that the relationships were so obvious as to not need articulation. This is evident in Ihle, Sodowsky, and Kwan (1996) where the authors measured demographic variables against worldview themes, suggesting an implicit awareness of the importance of environment. What is discouraging is that although most articles acknowledge the

importance of the relationships only three (Allen & Crawley, 1998; Cobern, 1996; McCabe, 1994) give rich explanations of the relationships.

Assumptions and universals. Only four of the eighteen articles (22%) distinguish between first- and second-order assumptions. All four of those articles are from science education. Of the fourteen articles that make no distinction, most deal strictly with fundamental assumptions either as axioms (Sarason, 1984), root metaphors (Lyddon & Adamson, 1992; Proper et al., 1988), or other themes. Only one of the articles dealt with second order assumptions; and again no distinction was made between first- and second-order assumptions.

Discussion and Conclusion

What lessons can be learned from this review? One of the most striking realizations for me as I conducted this review was the mismatch between worldview as conceptualized in science education literature and that conceptualized in educational psychology literature. Given differences in the use of worldview theory (thematic vs. logico-structuralism), methods employed (quantitative vs. qualitative), and application of assertions there are really two distinct conceptualizations of worldview and consequently two distinct bodies of worldview literature.

The worldview understood and studied by science educators is a holistic mass of macro and micro-thought undergird by a set of guiding assumptions (first-order assumptions). The aim of worldview studies in science education has been to learn about those guiding assumptions. The worldview understood and studied by educational psychologists are types or tendencies. The aim of worldview studies in educational psychology has been to identify (a) which worldviews or

types are associated with various demographic groups, and (b) how fit between worldviews or types affect practice.

Also notable is the similarity between worldview as conceptualized in science education literature and that conceptualized in educational psychology literature. Both acknowledge that worldview is shaped by environmental experiences, and both also acknowledge that worldview influences behavior to some degree. Both use worldview predominately as a tool for research. There are comparatively few essays and of those few, most synthesize research. Further, this review contains no instances of worldview being used to describe practice or interventions.

A second lesson that can be derived from this review is the effectiveness of qualitative methods for eliciting the richness of the logico-structural model of worldview theory. There were two studies, which used the logico-structural approach in concert with statistical research methods (Lawrenz & Gray, 1995; Ogunniyi et al., 1995). Both of these reports lacked the richness of reports mentioned earlier (e.g. Allen & Crawley, 1998). The biggest weakness of the articles is that the worldview data presented was acontextual leaving many unanswered questions regarding the worldviews of the participants. This seemed to be a methodological flaw.

How can worldview studies from other disciplines inform worldview research in science education? The thematic approach of studies from educational psychology can be beneficial to science education researchers. To do so, one concern that must be satisfied is that the themes (unlike the themes used in the educational psychology studies) should be emic, emanating from the frame of those being studied. Studies like Allen (1998) and Cobern (1993) provide emic worldview data that could serve as the basis from which themes are derived to conduct thematic worldview studies on larger populations. What is promising is that there are several instruments

that could be appropriated to such studies if properly modified. Finally, the distinction between first- and second-order assumptions and the use of Kearney's worldview universals are vastly underutilized resources. It is critical that future worldview studies in science education incorporate these assertions into their data collection and analysis if such studies are to impact student knowledge research.

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ARTICLE CHARACTERISTICS	Article	Type of Article	Area of Discipline	Use of Worldview
RESEARCH CHARACTERISTICS	Research Design	Methods of Data Collection	Sample	Analysis
LOGICO-STRUCTURAL ASSERTIONS	Assertion 1 Environmental Influenced	Assertion 2 Influence on Behavior	Assertion 3 Distinguish 1st and 2nd order assumptions	Assertion 4 Use of Universals
1. (Proper et al., 1988)		Report of Research	Science Education	Thematic - used Pepper's (1970) world hypothesis
Discourse Analysis		audiotaped and transcribed teachers' talk	3 lessons from each of 22 teachers	statements were grouped as one of 6 world hypothesis
No		No	No	No
2. (Kawagley, Norris-Tull, & Norris-Tull, 1998)		Essay	Science Education	Synonym for Culture
N/A		N/A	N/A	N/A
No		No	No - assumptions presented are 1st order assumptions, but no distinction is made from 2nd order assumptions.	No
3. (Cobern, 1996)		Essay	Science Education	Logico-Structural Model
N/A		N/A	N/A	N/A
Yes		Yes	Yes	No
4. (Ogunniyi et al., 1995)		Report of Research	Science Education	Logico-Structural Model
Statistical		Survey (Likert-type Instrument)	250 science teachers from 5 countries	Percentages were calculated for the survey responses
Yes		Yes	No	No
5. (Lawrenz & Gray, 1995)		Report of Research	Science Education	Logico-Structural Model
Statistical		Open ended Questionnaire	48 post-BA student science teachers	Researchers used responses to generate categories for each question.
Yes		Yes	No	Yes
6. (Cobern, 1993)		Report of Research	Science Education	Logico-Structural Model
Case Study		Interviews augmented by elicitation devices	15 college nursing students	development of concepts maps and 3rd person narratives
Yes		Yes	Yes - Assumptions are developed from the data.	Yes - He focuses on 1 universal (Non-Self) specifically nature.

7. (Allen & Crawley, 1998)	Report of Research	Science Education	Logico-Structural Model
Interpretive	Ethnographic. Audiotapes, videotapes, journal notes, artifacts, and contact summary forms. Data collected over 18 month period from various cultural scenes.	28 students, 2 teachers, 2 science textbooks, adults from the Kickapoo tribe	Emergent codes were developed from the data over the course of the study and grouped into major themes.
Yes	Yes	Yes	No - She acknowledges them and speaks of them but they do not influence data collection or analysis.
8. (Cobern, 1997)	Report of Research	Science Education	Logico-Structural Model
Statistical	Survey -TOPE (Test of preferred Explanations	208 participants. (88 scientists & 120 liberal arts students)	ANOVA & t-test
Yes	Yes	Yes	Yes - with focus on causal universal.
9. (Lyddon & Adamson, 1992)	Report of Research	Counseling	Thematic - Used Pepper's model
Statistical	Survey - OMPI (Organicism-Mechanism Paradigm Inventory) Previously developed instrument	90 undergraduate students (69 women, & 21 men)	Descriptive Correlation & ANOVA
No	No	No - Used Pepper's (1942) Root Metaphors	No
10. (Sarason, 1984)	Essay	Psychology	Corresponds to logico-structural model
N/A	N/A	N/A	N/A
Yes	Yes	No - Refers to axioms (similar to 1st order assumptions) which undergird worldview. Does not distinguish them from 2nd order assumptions.	No
11. (McCabe, 1994)	Report of Research	Cross-cultural Education	Thematic
Interpretive	Participant observation, interviews, student journal	23 undergraduate students	Taxonomic, Domain, & Theme analysis taken from Spradley (1979)
Yes	No	No - addresses only 2nd order assumptions	No

12. (Ihle et al., 1996)	Report of Research	Counseling	Thematic
Statistical	SAWV (Scale to Assess World Views)	180 women (47 White clients, 66 White counselors, 67 Chinese students	ANOVA & MANOVA (for a subset)
No - Though they do look at relationships to demographic variables	No	No	No
13. (Michel, 1996)	Essay	Religion Education	Paradigmatic
N/A	N/A	N/A	N/A
Yes	Yes	No - deals only with 1st order assumptions	No
14. (Sodowsky et al., 1994)	Report of Research	Counseling	Thematic & Paradigmatic
Statistical	SAWV (Scale to Assess World Views)	243 participants (109 White Americans, 67 Chinese, 28 Taiwanese, 40 Africans)	MANOVA
Yes	Yes	No	No
15. (Ewing, Richardson, James-Myers, & Russell, 1996)	Report of Research	Educational Psychology	Thematic
Statistical	IPS (Harvey Impostor Phenomenon Scale); RIAS (Racial Identity Attitudes Scale); *BSAS (Belief Systems Analysis Scale - source of worldview data); ASCS (Academic Self-Concept Scale); SIS (Student Information Survey).	103 African American graduate students (72 female, 31 male)	ANOVA & Multiple Regression
Yes	Yes	No	No
16. (Kwan, Sodowsky, & Ihle, 1994)	Report of Research	Higher Education	Thematic
Statistical	SAWV (Scale to Assess World Views)	139 international college students (6 from Hong Kong, 101 from mainland China, & 33 from Taiwan)	ANOVA
Yes	Yes	No	No

17. (Heppner & Duan, 1995)	Essay	Higher Education/Career Development	Synonym for Culture
N/A	N/A	N/A	N/A
Yes	Yes	No	No
18. (Ayalon & Yogev, 1996)	Essay	Religion Education	Paradigmatic
N/A	N/A	N/A	N/A
Yes	Yes	No	No